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ORIGINS OF SOLAR SYSTEMS:

REMOVING ACTIVITY-RELATED RADIAL VELOCITY NOISE

TO IMPROVE EXTRASOLAR PLANET SEARCHES

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Progress Report

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We have continued the super high resolution (R~200,000), high S/N (>300) echelle study of joint line bisector and radial velocity variations using the McDonald 2-D coude. Observing runs in October 2000 and March 2001 were plagued by poor weather, but runs in June and October 2001 were good. We have made a preliminary analysis (Saar et al. 2002) of the limited data in hand, and find some tantalizing evidence for correlations between median line bisector displacement and radial velocity v_r. The correlation appears to be specific the particular star being considered, probably since it is a function of both spectral type and rotation rate. Initial results were presented in Saar et al. (2002). This work is in collaboration with Harvard student Neil Snyder, Univ. of Texas, Austin PhD thesis student Diane Paulson, and Univ. of Heidelberg PhD thesis student Sebastian Els.

We have redone the analysis of the rms vr noise (σ_{vr} in the Lick planet survey data first made by Saar et al. (1998). The v_r timeseries studied now spans five years (two more than in the Saar et al. study). We also added early results of the Keck Hyades survey (Hatzes & Cochran 2000) which has a similar v_r precision (~3 m/s). We find correlations between σ_{vr} and B-V color, projected rotation velocity v sin i, rotation period P_{rot}, and Ca II HK emission which are quite similar to those of Saar et al. (1998), though show slightly higher scatter. We suspect this is due to the fact that longer v_r timeseries now spans a larger fraction of a stellar magnetic cycle (or a larger range of variability) than the earlier, shorter timeseries. The new correlations reflect the addition of an added variability component. We are exploring models to help explain and predict the added σ_{vr}. Initial results were presented in Saar et al. (2002) and form the core of a new journal paper (Saar 2002a, in preparation). We also find that the Hyades data agrees well with the trends seen in the Lick data, and emphasize the σ_{vr} minimum in mid-to-late K stars (Paulson et al. 2002). Thus, even relatively active stars in this spectral range are still good targets for planet searches. We find however, that simple ways of correcting v_r noise using activity fluxes (e.g., Saar & Fischer 2000) will likely be ineffective (Paulson et al. 2002).

Searches for excess non-radiative heating induced in the parent stars of extrasolar giant planets (Saar & Cuntz 2001) revealed that a weak approximately one year periodicity was buried in the Ca II infrared triplet data used in Saar and Fischer (2000). We've since explored whether removing this signal (possibly due to a seasonal modulation in the spectrograph's scattered light) improves the correlations between Ca II and v_r first noted by Saar and Fischer. Indeed, removing the spurious one year signal improves the average v_r correction possible by this method (from 45% to 57% of the total non-random noise). The fraction of successfully corrected stars drops somewhat though, from 29% to 22% of the Lick planet survey sample. This is likely because a few of the previously seen ``correlations" were actually the result of the spurious periodicity. Initial results were presented in Saar et al. (2002), and will be included in a future journal paper (Saar 2002a).

We have also begun detailed semi-empirical modeling of the effects of plage on v_r noise in rotating G stars using solar line bisectors at various disk positions and plage intensities as proxies for stellar ones. We find a somewhat different rotational phase dependence for the v_r perturbation than predicted previously using simpler models (Saar et al. 2001), but the amplitudes are still large enough in active stars to be troublesome (as much as 60 m/s in the worst cases for v sin i >5 km/s). We plan to present initial results at the DC Exoplanet meeting in June 2002; a paper is also in preparation (Saar 2002b).

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